CLAIMS

1. A semiconductor device comprising:

an organic insulating film having an opening,

wherein said organic insulating film has a modified portion facing said opening, and

said modified portion includes nitrogen atoms.

2. The semiconductor device according to claim 1, wherein said modified portion further comprises fluorine atoms, and

a concentration of said fluorine atoms in said modified portion is lower than a concentration of said nitrogen atoms.

3. The semiconductor device according to claim 2, further comprising:

a metal conductor whose main component is copper, formed in said opening.

4. The semiconductor device according to claim 3, wherein said metal conductor is in direct contact with said modified portion.

5. A manufacturing method of a semiconductor device, comprising:

(a) forming an organic insulating film on a

top surface side of a substrate;

(b) etching said organic insulating film to form an opening; and

(c) forming a modified portion including nitrogen atoms in a portion of said organic insulating film facing said opening.

6. The manufacturing method of the semiconductor device according to claim 5, wherein said modified portion further comprises fluorine atoms, and

a concentration of said fluorine atoms is lower than a concentration of said nitrogen atoms.

7. The manufacturing method of the semiconductor device according to claim 6, wherein said (b) etching said organic insulating film comprises:

etching said organic insulating film by using an etching gas containing a nitrogen gas and a fluorocarbon, and

said (b) step and said (c) step are carried out at a same time.

8. The manufacturing method of the semiconductor device according to claim 7, wherein a molar ratio of said nitrogen gas is 50% or more of said entire etching gas.

9. The manufacturing method of the semiconductor device according to claim 8, wherein a molar ratio of said nitrogen gas is 70% or more of said entire etching gas.

10. The manufacturing method of the semiconductor device according to claim 7, wherein generation and stop of the generation of a plasma for said etching are alternately executed in said (b) etching said organic insulating film.

11. The manufacturing method of the semiconductor device according to claim 7, wherein while said (b) step is executed, application and stop of the application of a bias to said substrate are alternately executed.

12. The manufacturing method of the semiconductor device according to claim 5, wherein said (c) step is executed by exposing said portion of said organic insulating film facing said opening to a plasma containing said nitrogen atoms.

13. A manufacturing method of a semiconductor device, comprising:

(d) forming an organic insulating film on a top surface side of a substrate; and

(e) etching said organic insulating film through a plasma containing nitrogen atoms to form an opening,

wherein at said (e) step, generation and stop of the generation of said plasma are alternately executed.

14. A manufacturing method of a semiconductor device, comprising:

(d) forming an organic insulating film on a top surface side of a substrate; and

(e) etching said organic insulating film through a plasma containing nitrogen atoms to form an opening,

wherein while said (e) step is executed, application and stop of the application of a bias to said substrate are alternately executed.

15. A manufacturing method of a semiconductor device, comprising:

(f) forming an organic insulating film;

(g) etching said organic insulating film to form an opening; and

(h) exposing said organic insulating film to a plasma containing nitrogen atoms, after forming said opening.

16. A manufacturing method of a semiconductor device, comprising:

(i) forming a first interlayer insulating film formed of an organic compound;

(j) forming a second interlayer insulating film formed of an organic compound, on a top surface side of said first interlayer insulating film;

(k) forming a wiring groove penetrating said second interlayer insulating film and a via-hole penetrating said first interlayer insulating film, through one etching process;

(l) forming modified portions containing nitrogen atoms, on a sidewall of said wiring groove and a sidewall of said via-hole; and

(m) embedding said wiring groove and said via-hole with conductors, after said (d) step.

17. The manufacturing method of the semiconductor device according to claim 16, wherein said modified portion further comprises fluorine atoms, and

a concentration of said fluorine atoms is lower than a concentration of said nitrogen atoms.

18. The manufacturing method of the semiconductor device according to claim 17, wherein in etching said wiring groove and said via-hole, an etching gas containing nitrogen atoms and fluoro-carbon are used

and said (l) step is executed simultaneously with said (k) step.